## REMARKS

**The Examiner rejected Claims 1-11 and 13-22 under 35 U.S.C. 102(b) as being anticipated by Zhu. Applicant traverses the rejection.**

The Examiner has the burden of showing by reference to the cited art each claim limitation in the reference. Anticipation under 35 U.S.C. 102 requires that each element of the claim in issue be found either expressly or inherently in a single prior art reference. In re King, 231 USPQ 136, 138 (Fed. Cir. 1986); Kalman v. Kimberly-Clark Corp., 218 USPQ 781, 789 (Fed. Cir. 1983). The mere fact that a certain thing may result from a given set of circumstances is not sufficient to sustain a rejection for anticipation. *Ex parte Skinner*, 2 USPQ2d 1788, 1789 (BdPatApp&Int 1986). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re* Rijckaert, 28 USPQ2d, 1955, 1957).

Claim 1 requires a detector signal related to the power of the radiation leaving a quantum absorber to exhibit an asymmetry as a function of modulation frequency about a frequency $\nu_0$. The Examiner points to Figure 5D and lines 11-28 of Column 12 of Zhu as providing these teachings. In addition, Claim 1 requires that the apparatus has an asymmetry servo loop and that this loop alters one of the frequency mid-way between the two CPT frequencies, the amplitude of the first CPT component, and the amplitude of the second CPT component, in a manner that reduces the detector signal asymmetry. The Examiner points to the AC Stark shift servo loop taught in lines 8-19 of Column 15 and Figure 7of Zhu, including detector 261 control signal 265 and spectrum control 214, as providing these teachings.

First, Applicant disagrees with the Examiner's reading of Zhu as providing the teachings required to satisfy the Claim limitation regarding detector signal asymmetry. Applicant submits that the passage in Zhu to which the Examiner points relates to a possible asymmetry about the **carrier frequency** in the intensity of the two CPT frequency components in the light 216 that is

incident on the quantum absorber. The Examiner has not pointed to any teachings in Zhu that this asymmetry inherently gives rise to any asymmetry as a function of **modulation frequency** in the signal 120 produced by the detector.

Hence, Applicant submits that the Claim limitation requiring the **detector** signal to exhibit an asymmetry about **modulation frequency** is not anticipated by the teachings of Zhu.

Second, Applicant disagrees with the Examiner's reading of Zhu as providing the teachings required to satisfy the Claim limitation regarding a servo loop that alters one of the frequency mid way between the CPT frequencies, the amplitude of the first CPT component, and the amplitude of the second CPT component in a manner that reduces the detector signal asymmetry. The Examiner states that the AC Stark shift servo loop will, by minimizing the the total AC Stark shift, also reduce asymmetry in the detector signal "about the carrier frequency".

First, Applicant submits that the Claim relates to minimization of asymmetry about the modulation frequency, not the carrier frequency.

Second, Applicant submits that the Examiner has not pointed to any teachings in Zhu that minimizing an imbalance in the intensities of the two CPT components, which is the only type of asymmetry taught by Zhu, will necessarily minimize any asymmetry in the signal output from the detector. Hence, the Examiner must be assuming on some other basis that it is **always** true that minimizing the AC Stark shift will also minimize the detector signal asymmetry as a functionof modulation frequency. In this regard, Applicant submits that the present invention in itself provides evidence rendering that assumption invalid, as the specification teaches that two servo loops are required, one to minimize the AC Stark shift (by controlling the additional frequency sidebands around the CPT frequencies), and another to minimize asymmetry in the detector signal as a function of modulation frequency (by shifting the central frequency or adjusting the amplitudes of the CPT frequency components). For example, lines 19-23 of Page 10 of the current invention state "In frequency standard 200, modulation controller 211 has inputs for controlling the modulation of both the phase and amplitude of the laser. One of these is used to

correct for the AC Stark Shift and the other is used to reduce the asymmetry of the transmission curve. The error signal generated by asymmetry error detector 205 is used by servo controller 208 to servo the amplitude modulation, and the error signal generated by AC Stark Shift detector 206 is used to servo the phase modulation." Hence, Applicant submits that it is **not** inherent that a servo loop that minimizes the AC Stark shift will also minimize detector signal asymmetry as a function of modulation frequency. Accordingly, Applicant submits that the Claim limitation related to the asymmetry servo loop is not inherent to the teachings of Zhu.

Hence, Applicant submits that Claim 1 and the Claims dependent therefrom are not anticipated by Zhu.

Claim 3, which depends from Claim 1, additionally requires that the laser frequency, $\nu_L$, is altered in response to the asymmetry of the detector signal. The Examiner has not pointed to any teachings in Zhu that the laser frequency is altered in response to any asymmetry of any kind. Hence, Applicant submits that there are additional grounds for allowing Claim 3.

Claim 13 requires a detector signal related to the power of the radiation leaving a quantum absorber to exhibit an asymmetry as a function of modulation frequency about a frequency $\nu_0$. The Examiner points to Figure 5D and lines 11-28 of Column 12 of Zhu as providing these teachings. In addition, Claim 13 requires that one of the frequency mid-way between the two CPT frequencies, the amplitude of the first CPT component, and the amplitude of the second CPT component, is altered in a manner that reduces the detector signal asymmetry. The Examiner points to the AC Stark shift servo loop taught in lines 8-19 of Column 15 and Figure 7of Zhu, including detector 261 control signal 265 and spectrum control 214, as providing these teachings.

As noted above with respect to Claim 1, Applicant submits that Zhu does not teach either that the detector signal exhibits an asymmetry about modulation frequency or that one of the frequency mid-way between the two CPT frequencies, the amplitude of the first CPT component, and the amplitude of the second CPT component, is altered in a way that minimizes

that asymmetry. Hence, Applicant submits that Claim 13 and the Claims dependent therefrom are not anticipated by Zhu.

**The Examiner rejected Claims 12 and 23 under 35 U.S.C. 103(a) as being unpatentable over Zhu.**

Regarding Claims 12 and 23, the Examiner states that Zhu discloses the apparatus of Claim 10 and method of Claim 21 but does not teach the specific limitations regarding the use of an ion as an isotope selected from the group consisting of $Be^+$, $Mg^+$, $Ca^+$, $Sr^+$, $Ba^+$, $Zn^+$, $Cd^+$, $Hg^+$, and $Yb^+$. The Examiner maintains that it would have been obvious to modify the device of Zhu by utilizing any of the above isotopes in the quantum absorber, instead of Cesium or Rubidium, as taught by Zhu, "for the purpose of ensuring the desired frequency and energy level transitions for the frequency standard."

First, as noted above with respect to Claims 1 and 13, from which Claims 12 and 23 depend, Applicant submits that Zhu does not teach the limitations of the base claims, regarding detector signal asymmetry, and the minimization of that asymmetry by altering one of the center frequency, the amplitude of the first CPT frequency component, or the amplitude of the second CPT component.

Second, Applicant disagrees with the validity of the motivation proposed by the Examiner for modifying the teachings of Zhu in a way that would satisfy the additional limitations of Claims 12 and 23.

The Examiner states that Zhu suggests that Cesium, Rubidium, any other alkali metal, or any other suitable atoms, ions or molecules may be used in the quantum absorber. The Examiner maintains that since the alkali metals are in group IA of the Periodic Table, and the ions specified in the Claims are from group IIA and IIB of the Periodic Table, "these elements must have similar properties" including similar ionization energies. The Examiner then suggests that "these similar ionization energies would translate to similar operational frequencies in a CPT system"

and hence, "one might choose among these elements based on the desired frequency of operation in a CPT frequency standard".

First, Applicant submits that not all of the ions listed in the Claims are from groups IIA and IIB.

Second, Applicant submits that the properties of elements vary significantly within and between different groups in the Periodic Table, even for those groups that are relatively closely situated. Ionization energy, in particular, is known to decrease as one moves from top to bottom within a group, and to increase as one moves from left to right from group to group across the Periodic Table. See, for example, http://ocikbws.uzh.ch/education/Elemnet/structure/periodic/trends/step2.html

The Examiner has not pointed to any teachings that the ionization energies of the ions listed in the Claims are any closer to those of the ions taught by Zhu than are any other ions that might be chosen.

Third, the Examiner has not pointed to any teachings that support the Examiner's assertion that similar ionization energies imply similar CPT operational frequencies. Applicant submits that the CPT effect involves a single excited state and two **ground** state energy levels separated by an energy gap in the microwave region, of interest for use in frequency standards, while ioniziation energies are determined by **outer shell** electron states and their levels relative to "free" i.e. unbound electrons. Hence, even if the ionization energies of potential isotope choices were similar, that would not necessarily provide any insight with respect to the choice of elements to be used in a CPT frequency standard.

Accordingly, Applicant submits that the Examiner has failed to make a *prima facie* case for obviousness with respect to Claims 12 and 23

I hereby certify that this paper is being sent by FAX to 571-273-8300.

Respectfully Submitted,

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